# Modern2020

## Monitoring programme for the Olkiluoto repository, Finland

Tuomas PERE, Posiva Ltd.

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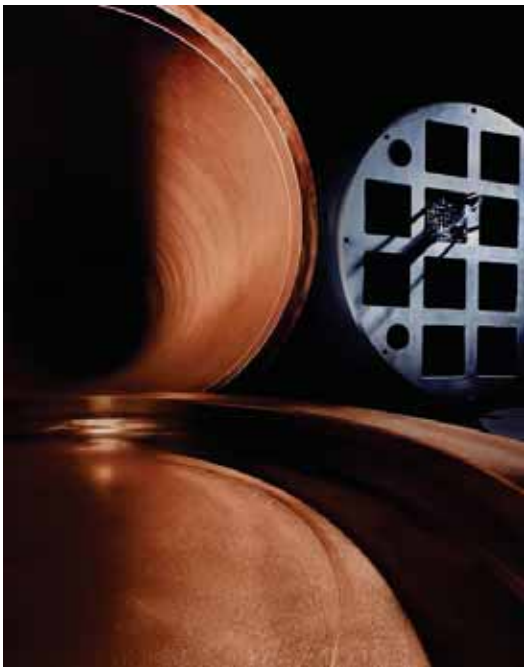
Cité Universitaire, Paris 9.4.2019

*This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement n° 662177*

# Posiva Ltd

- Posiva Ltd (Posiva)
  - ✓ Mission
    - Safe and cost efficient final disposal of spent nuclear fuel for our owners
  - ✓ Vision
    - Forerunner in industrial final disposal of spent nuclear fuel
  - ✓ Established in 1995
  - ✓ Private company, owned by Finnish NPP operators TVO and Fortum
  - ✓ Turnover 67 M€ (2017)
  - ✓ 81 staff + in addition expertise from partners
- Posiva Solutions Ltd (PSOY)
  - ✓ Provides tailored expert services related to final disposal of spent nuclear fuel in collaboration with an extensive network of partners
  - ✓ 3 staff + in addition expertise from Posiva and partners
  - ✓ Expertise is based on Posiva's decades-long experience in design, research and development
  - ✓ Established in June 2016, subsidiary of Posiva



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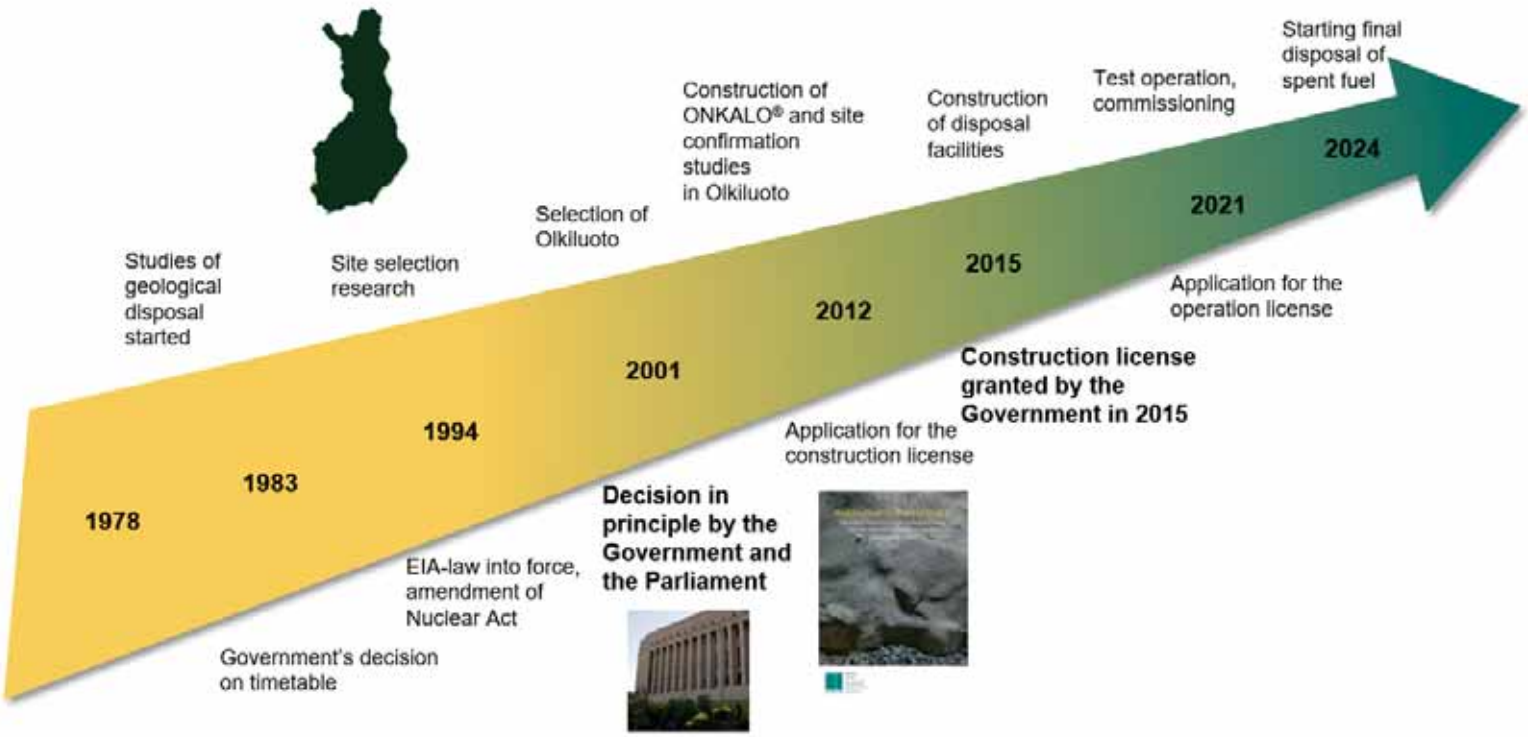
# Posiva's program has progressed already for 40 years

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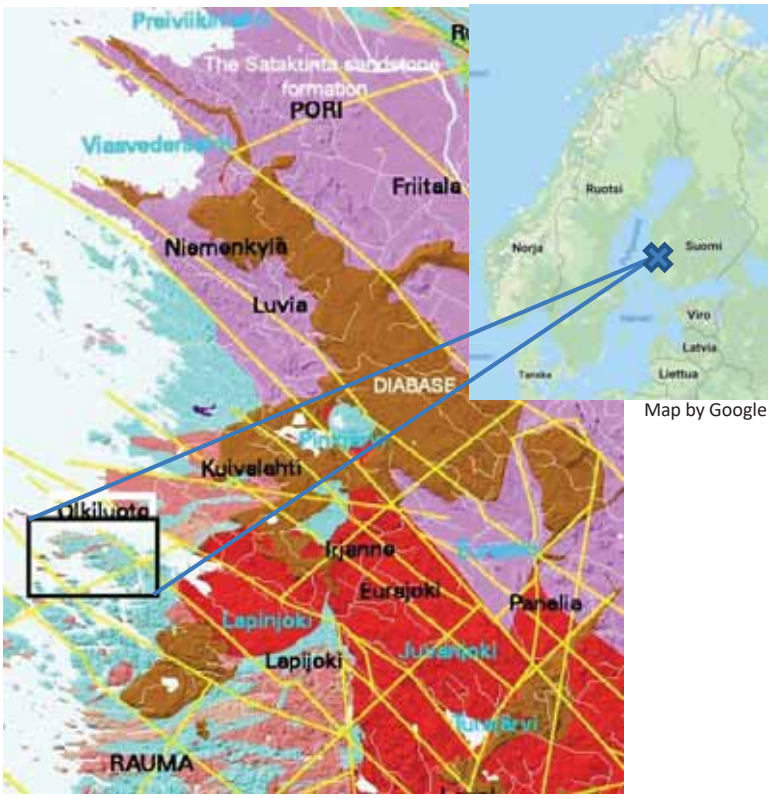
# Geological context

- Finland is located within the Fennoscandian shield.
- Olkiluoto is located in precambrian metasedimentary migmatites aged ~1.9-1.8 Ga.
- Intrusions of rapakivi-granite (~1.6-1.5 Ga) and diabase (~1.2 Ga) are also found within kilometers from the research area.
- The satakunta sandstone formation (~1.6-1.3 Ga) is located ~15 km NE and ~5 km W from Olkiluoto.




Map by Google

Map by Geological survey of Finland (GTK)

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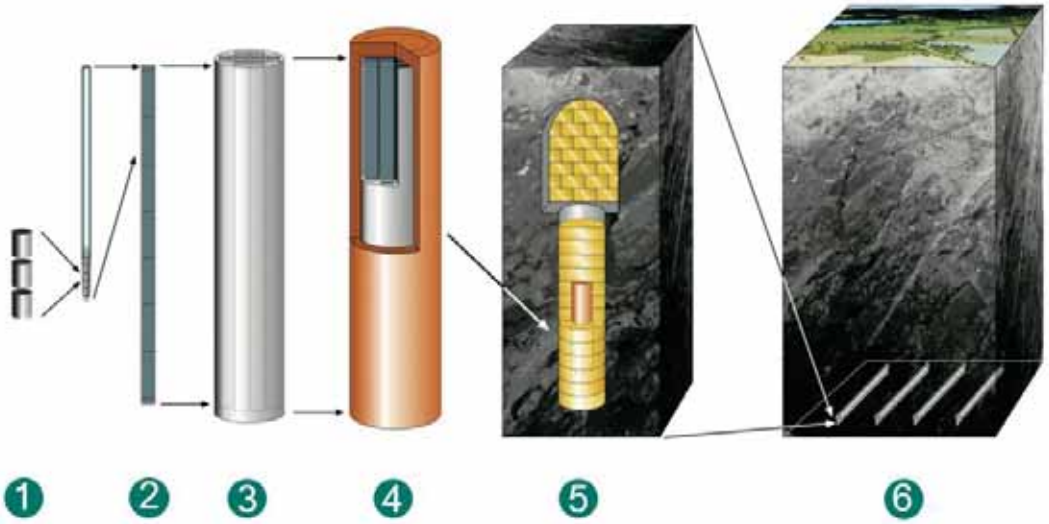
# Concept

## Multiple barriers of final disposal - KBS3-V




1. Fuel pellet
2. Fuel rod and assembly
3. Canister iron insert
4. Copper overpack
5. Bentonite buffer and tunnel backfill
6. 420 meters of crystalline bedrock

Several release barriers back up each other and ensure long-term safety.

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# Why to monitor?

- Regarding geological disposal, a monitoring program for the site is either directly or indirectly required by several national laws, decrees and guides as well as in international guidance.
  - ✓ e.g. Nuclear safety guides (YVL), Regulation STUK Y/4/2016, Nuclear energy act, Environmental protection act.
    - In addition, monitoring is required in different licences (construction licence, environmental licence).
    - International guidelines for monitoring have also been set in IAEA Safety Standards, Specific Safety guides and TECDOCs.
    - Microseismic monitoring is also part of the safeguards- work done in order to prevent unauthorized distribution of nuclear materials
- Monitoring is continuous work, started already before the construction of ONKALO®, in the beginning of the 2000's.
- Monitoring shall be continued during the whole construction and operation phase of the final disposal facility, until at the time of closure it shall be shown that the conditions at the site will return to natural state, resembling the conditions at the site before the construction works.

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# Monitoring objectives

## Main objectives for monitoring:

- Long term safety (site). Demonstrating that the conditions in the surroundings of the repository remain favorable for long-term safety despite repository construction and operation.
- To collect additional information regarding long-term safety critical properties of the site
- For ensuring the suitability of the site.
- For developing site models.
- To monitor the environmental impacts of the project.
- To gather data and provide feedback for construction and design on the impact of construction on the geosphere and surface environment.
- To monitor the function of the engineered barriers for ensuring that they function as planned and expected.

Important to start baseline studies and monitoring well before the construction activities so that sufficient baseline can be established

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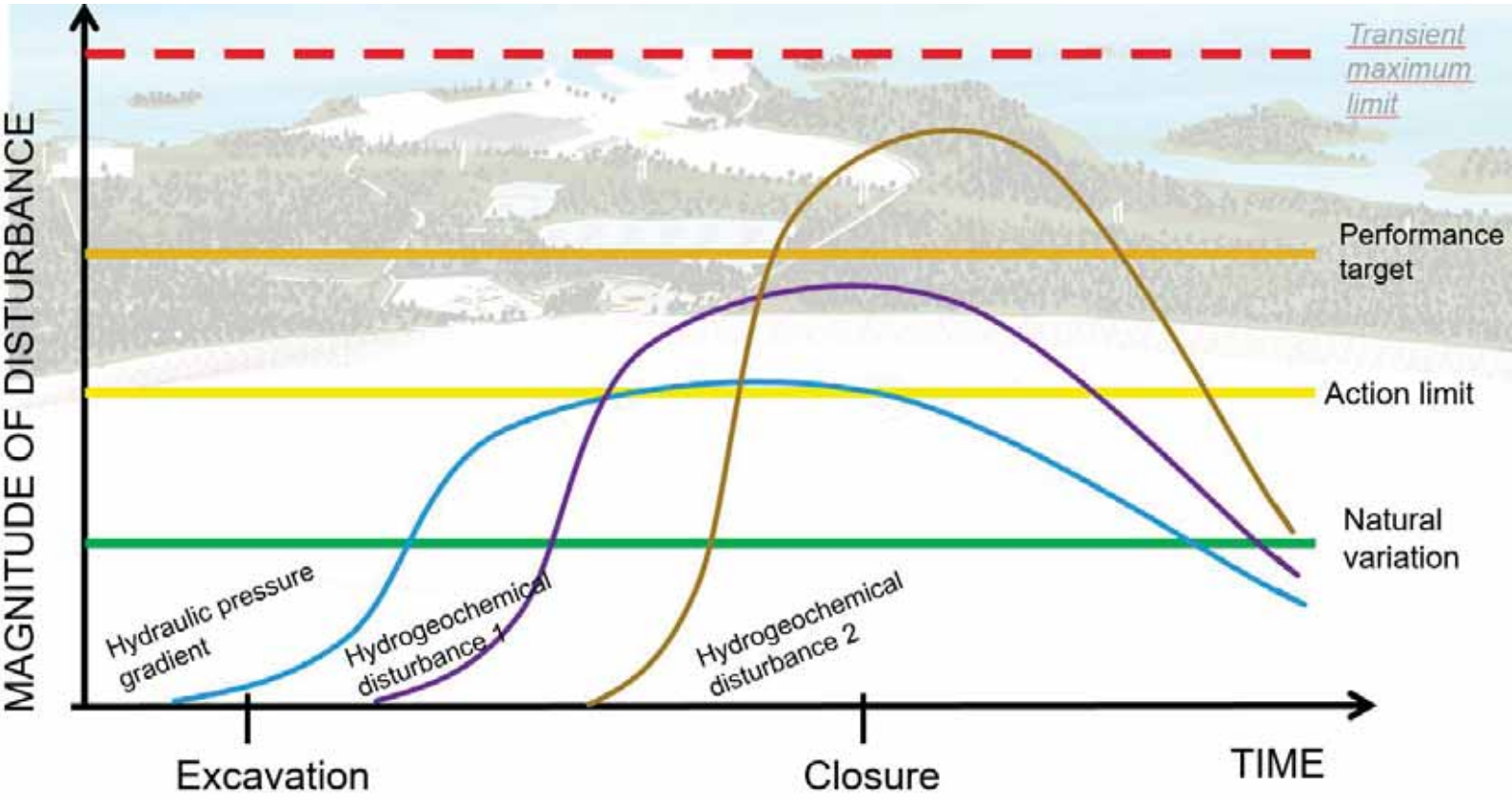
# The work of monitoring is completed after construction-related disturbance and following recovery towards natural conditions have been detected

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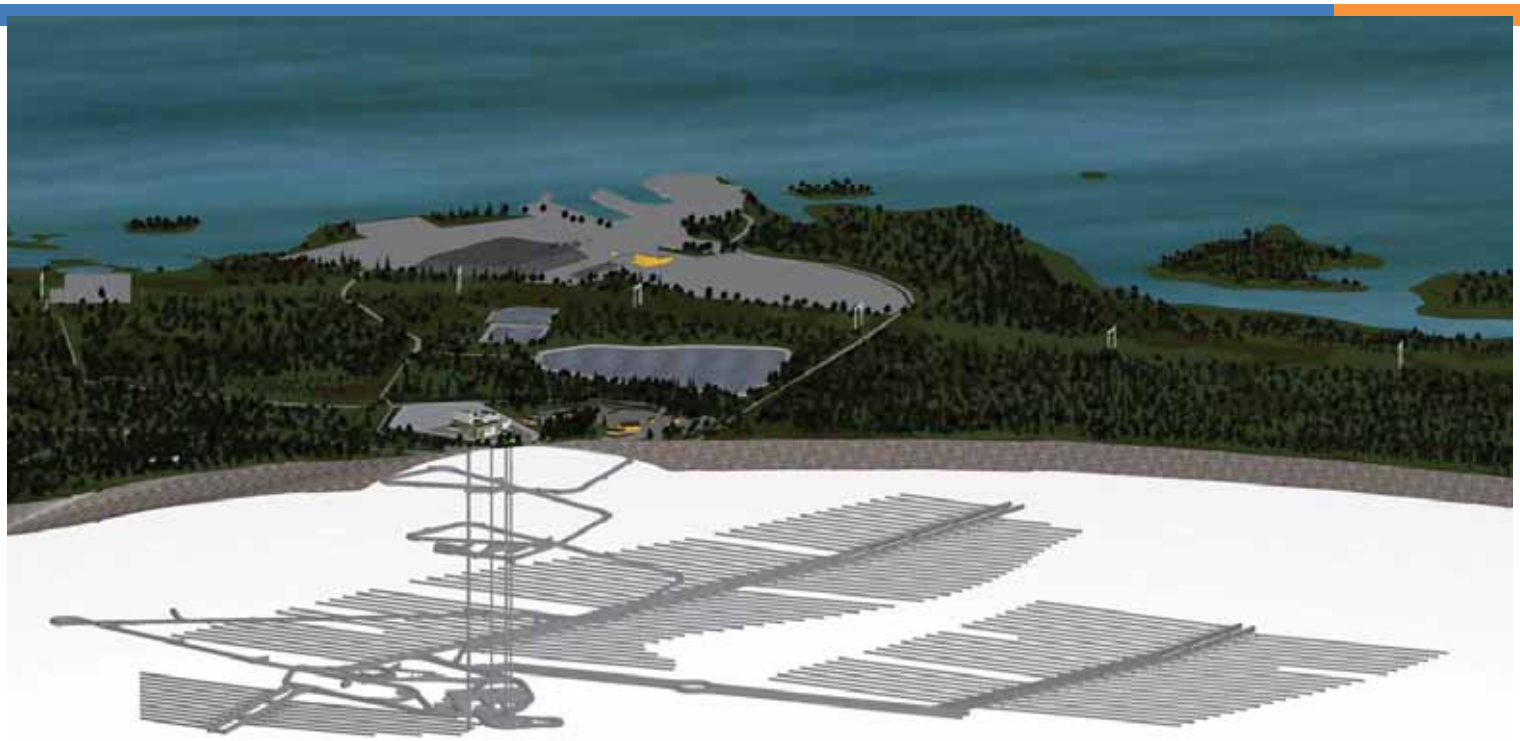
# Preserving the suitable conditions



- In the repository area, the conditions must remain suitable enough during the whole lifecycle of the reposirtory, including the operational period.
- ”Suitable enough” means that construction-related disturbances can occur. However, the disturbances shall not jeopardize the long-term safety of the system.

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# Monitoring programme structure

- The monitoring programme has been divided to sub-sections with respective coordinators
  - ✓ Programme coordinator: Tuomas PERE
    - Overall coordination of the monitoring programme, guidance, reporting, external contacts to authorities and internal contacts within Posiva.
  - ✓ Rock mechanics: Sophie HAAPALEHTO
    - Monitoring of berdock movements, rock stress, temperature, seismics and excavation-related blasts
  - ✓ Hydrogeochemistry: Marja VUORIO
    - Monitoring of groundwater chemistry
  - ✓ Hydrology and hydrogeology: Petri KORKEAKOSKI
    - Monitoring of groundwater flow, pressure and surface
  - ✓ Surface environment: Tiina SOJAKKA
    - Monitoring of environmental impact
  - ✓ Engineered barriers: Johanna HANSEN
    - Monitoring of the engineered barriers

- In addition to the aforementioned:
  - ✓ ~10 own personnel related to reporting, other monitoring tasks and coordination of works
  - ✓ ~10 own personnel related to field work and maintenance of monitoring networks
  - ✓ ~20 expert consultants

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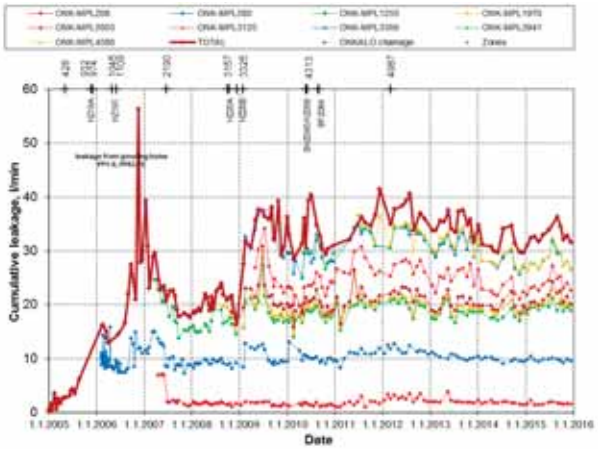
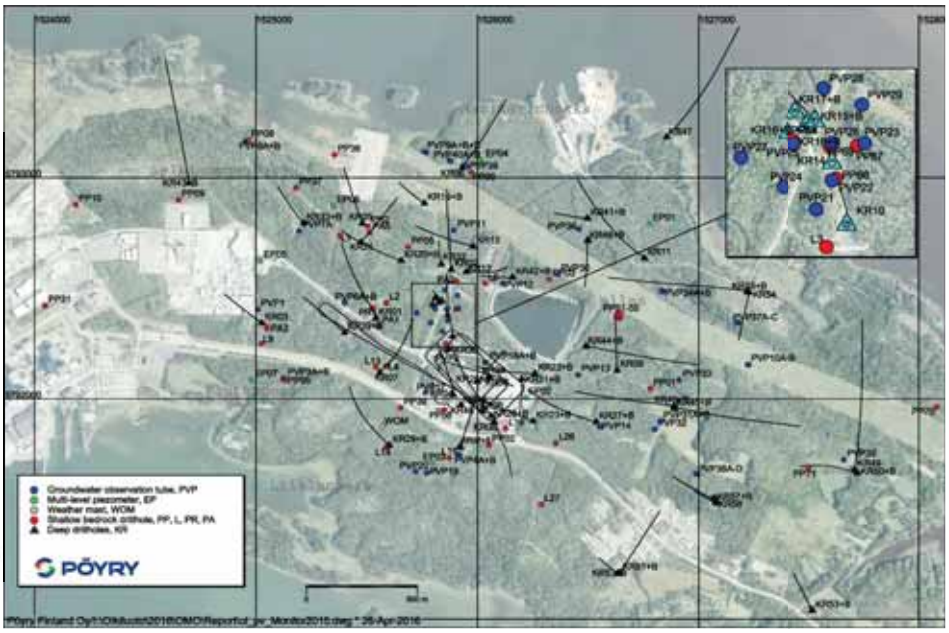
# Hydrology and hydrogeology

- Follows the groundwater pressure changes in packed deep drillholes, shallow drillholes, groundwater tubes and ONKALO®.
  - ✓ Also monitors hydraulic connections at the site as well as water inflow to ONKALO®.

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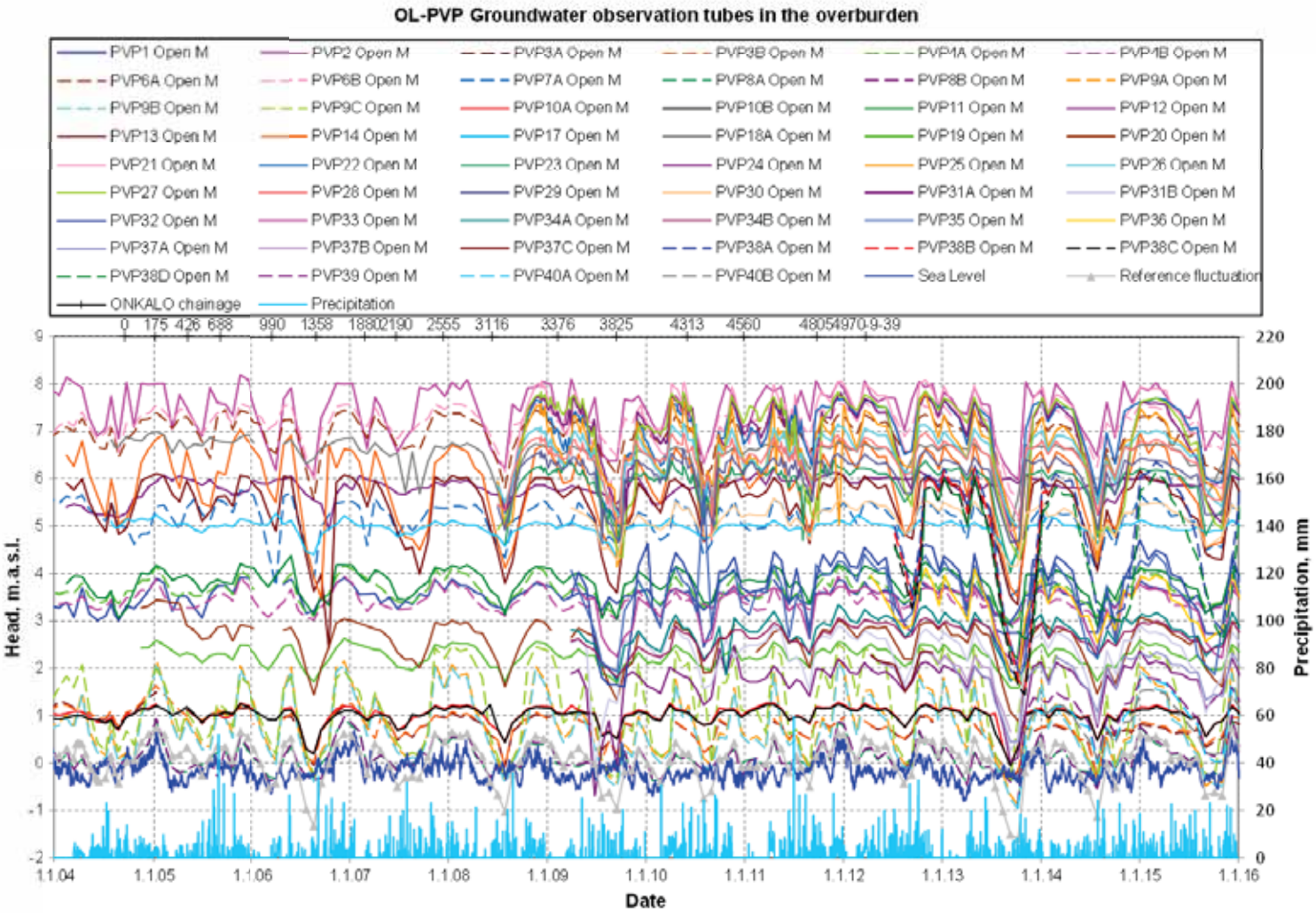


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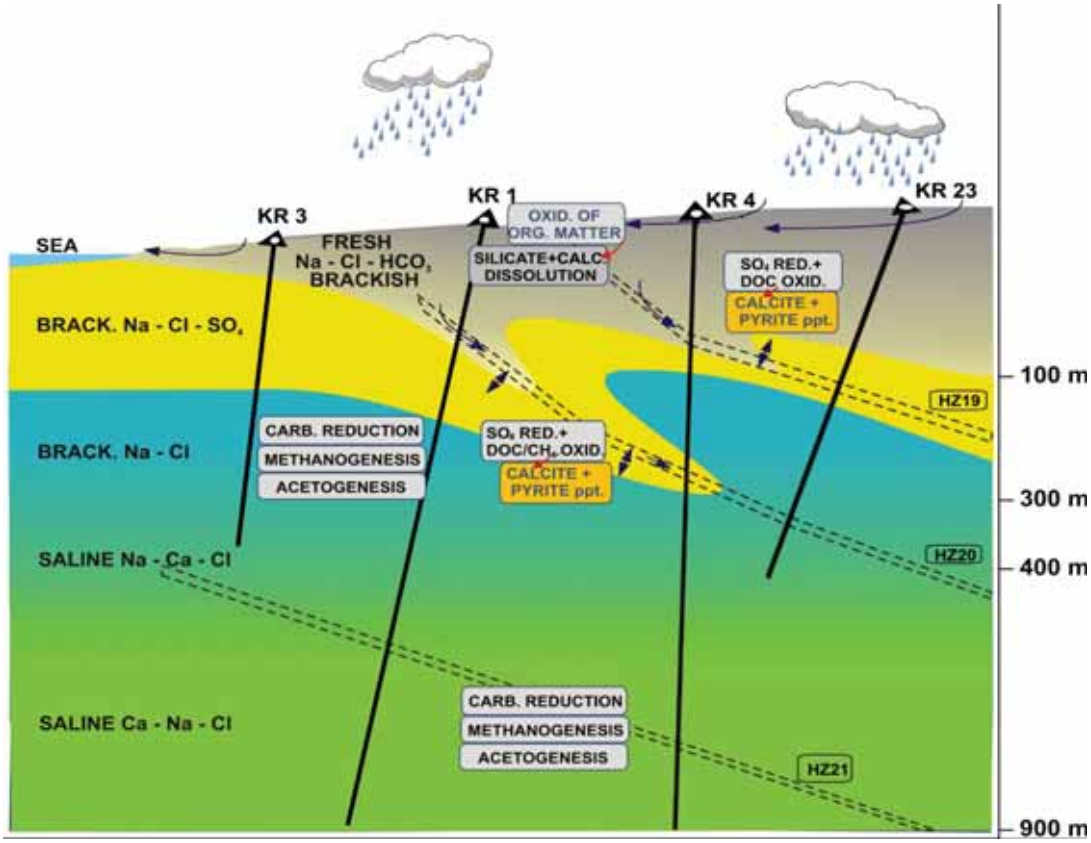
# Hydrogeochemistry

- Follows the geochemical composition of groundwater at the site from deep and shallow drillholes, groundwater tubes and ONKALO.

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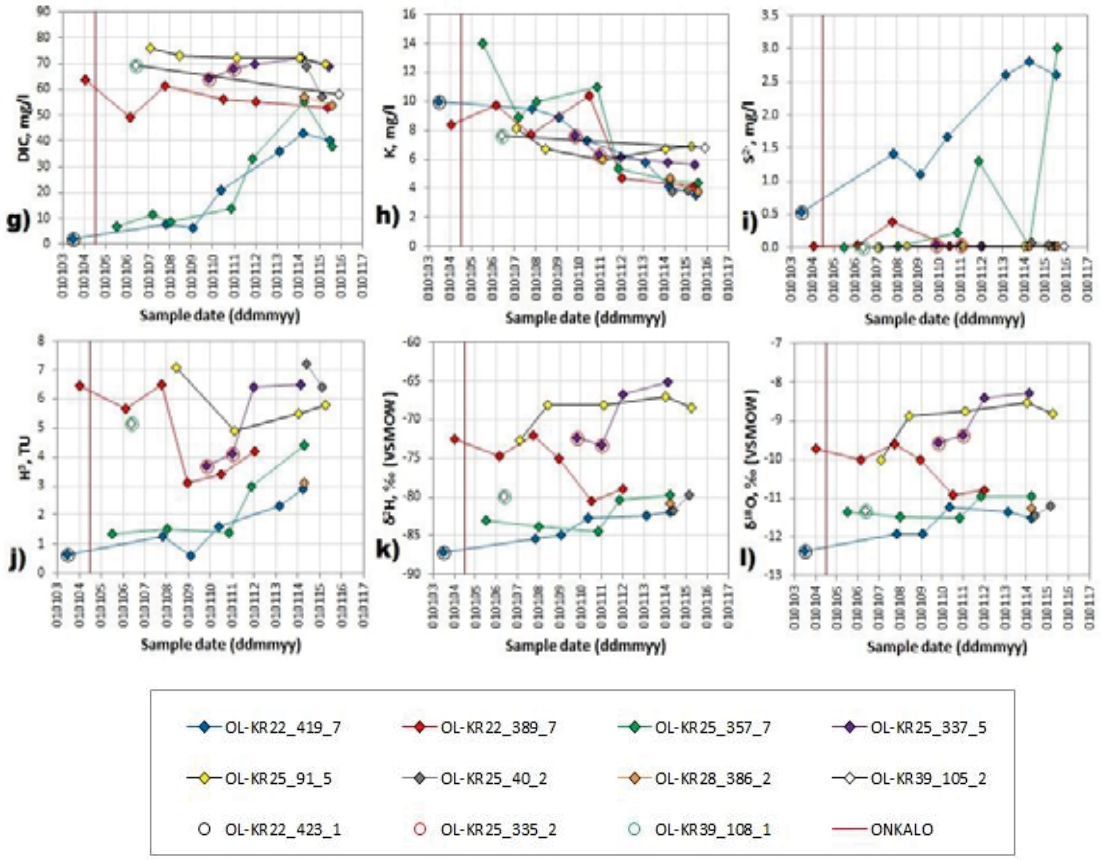
# Deep boreholes with multi-packer systems – hydrogeochemical changes

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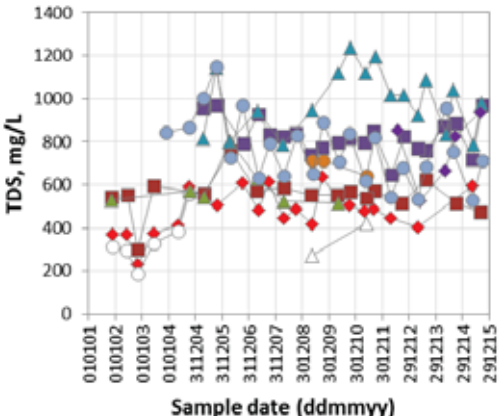
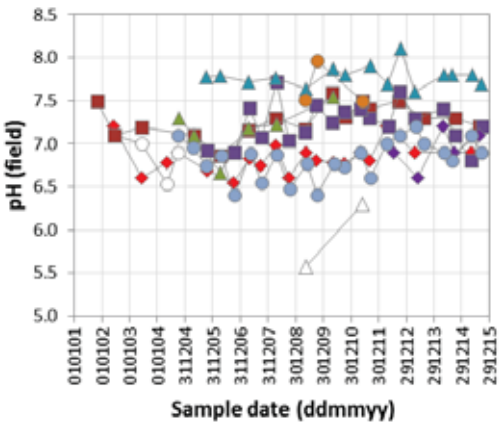
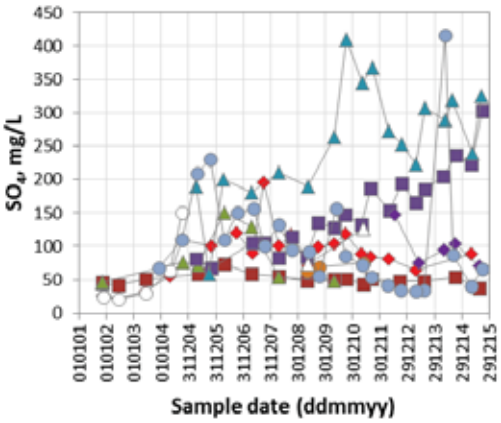
MODERN 2020

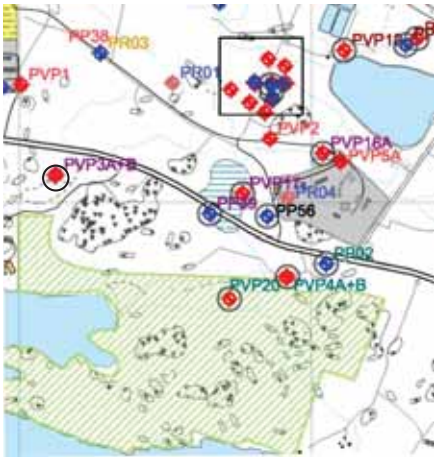
Development and Demonstration of monitoring strategies and technologies for geological disposal

OL-PVP3A, OL-PVP3B, OL-PVP10A, OL-PVP10B, OL-PVP17, OL-PVP18A, OL-PVP34A, OL-PVP34B, OL-PVP36, OL-PP39

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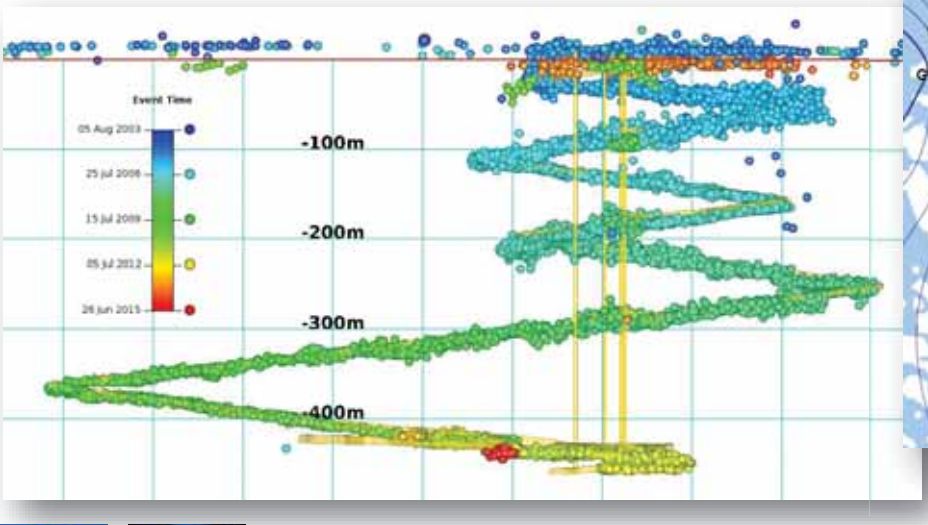
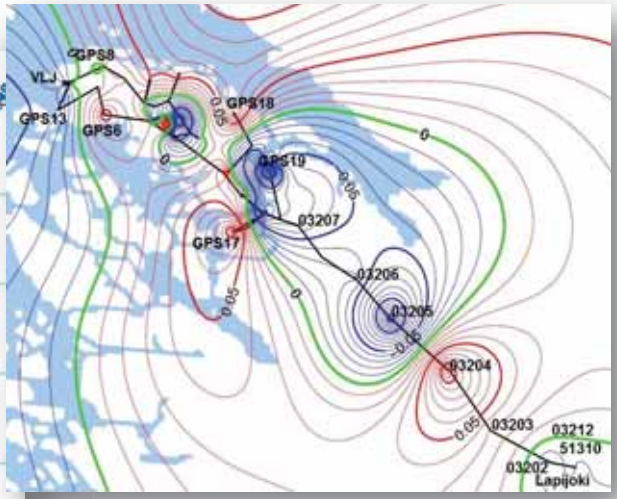
# Rock mechanics

- Monitors the rock mechanical evolution of the site
  - ✓ Seismicity (microseismic network)
  - ✓ Rock stress (visual observations, extensometers)
  - ✓ Land uplift (precise levelling)
  - ✓ Bedrock movements (GPS)

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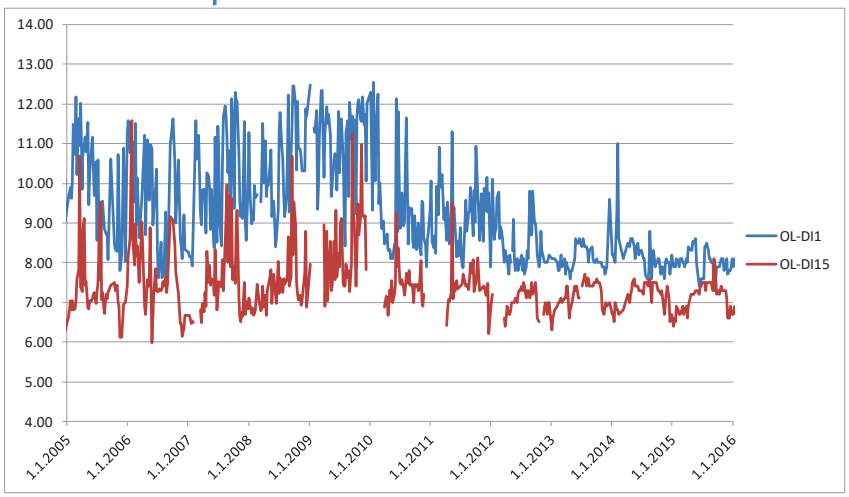
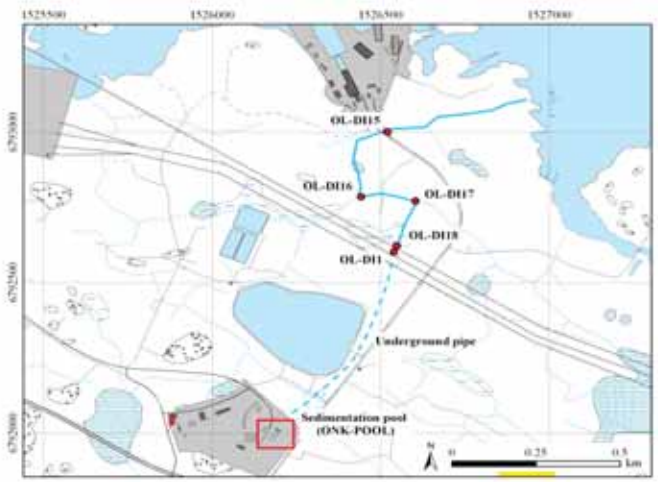
# Surface environment

- Follows the environmental effects of the final disposal and related long-term construction, excavation & rock piling works.
  - ✓ Surface water quality
  - ✓ Noise
  - ✓ Well water quality
  - ✓ Biosphere



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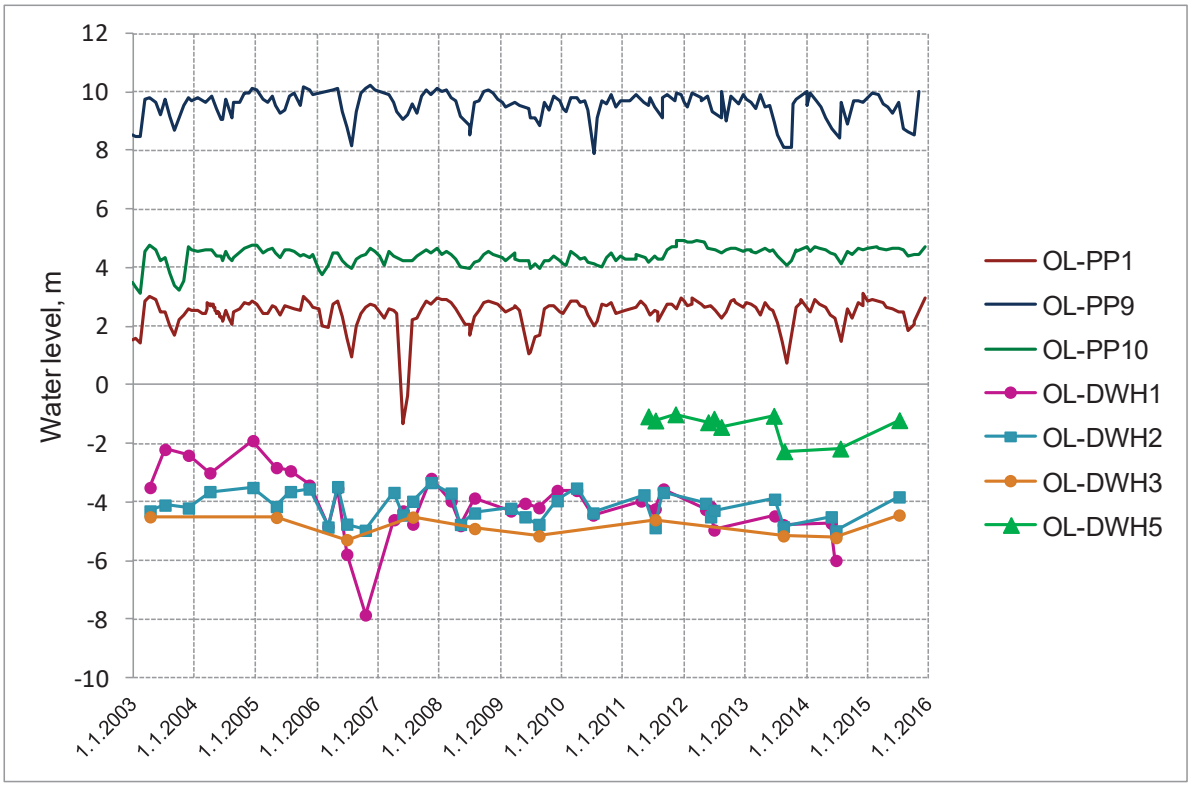
# Water level in private wells

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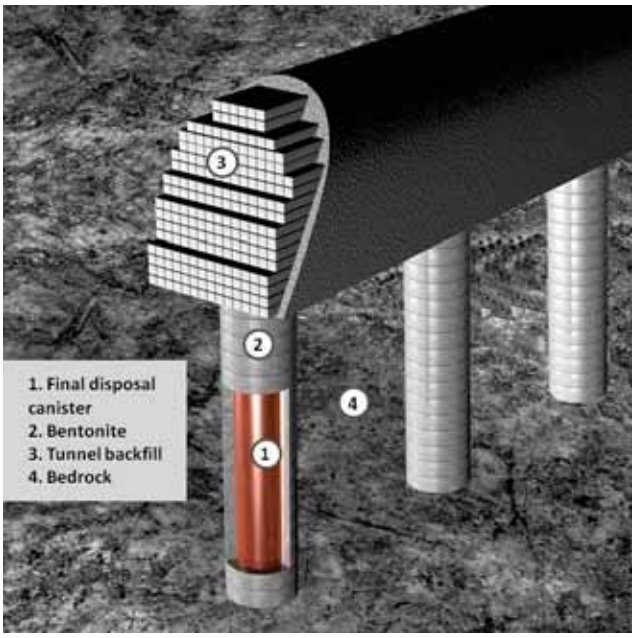
# Engineered barriers

- YVL guide D.5. Requirement 506, e.
  - ✓ States that monitoring of the performance of engineered barriers must be done
  - ✓ Will be implemented in the operational phase
  - ✓ Plans and methods currently under development
    - Approach based mainly on passive safety of the disposal system
    - Monitoring of the EBS-components based primarily on monitoring of underground tests and experiments as well as indirect monitoring by monitoring the surrounding conditions in the bedrock
    - Based on the assumption that no monitoring equipment will generally be behind the plug, in contact with the actual EBS-components in the actual disposal tunnels or holes
    - Wireless monitoring methods are however currently being developed and tested in cooperation with VTT and if found feasible, their implementation in some parts of the repository can be considered
      - IPR-rights for nuclear waste applications regarding the wireless monitoring methods in question are owned by Posiva Ltd.

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# Monitoring programme report

- The latest published monitoring programme report is Posiva report 2012-01.
  - ✓ Not the most recent version of the programme
  - ✓ Available on Posiva's website
  - ✓ Includes a detailed description of the programme at the time
  - ✓ Monitored processes, parameters, targets and schedules as well as related regulation details
  - ✓ Also includes action limits for the parameters
  - ✓ Monitoring programme will be updated as Posiva applies for the operational license

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